Construct, Conduct & Comprehend Physics Experiments

LEOK-3-31 Study on Abbe Imaging Principle & Optical Spatial Filtering

- *Complete set*
- *Cost effective solution*
- *Detailed instructional manual*
- *Easy alignment*

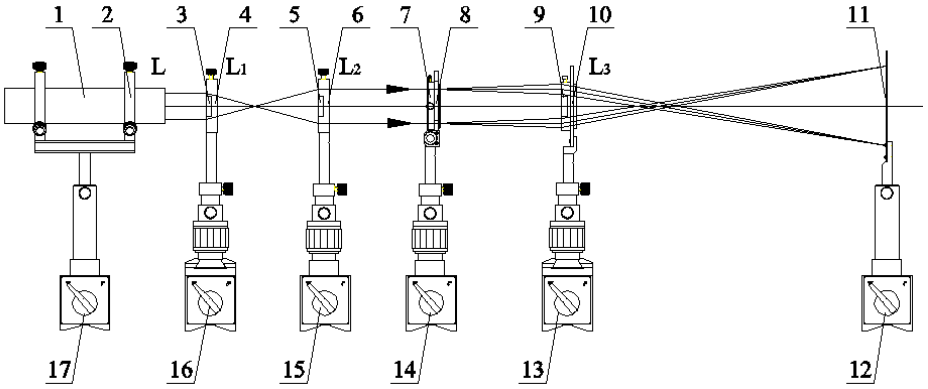


Figure 31-1 Schematic of experiment setup

1: He-Ne Laser (LLL-2)
2: Laser Holder (SZ-42)
3: Beam Expander Lens L_1 (f' =6.2 mm)
4,6: Lens Holder (SZ-08)
5: Collimating Lens L_2 (f'=190 mm)
7. Grating (20 lines/mm)
8: Bi-prism Holder (SZ-41)
9: Fourier Lens L_3 (f'=225 mm)
10: Rotary Lens Holder (SZ-06A)
11: White Screen (SZ-13)
12~17: Magnetic Base (SZ-04)
Others: Adjustable Slit (SZ-27B), Plate Holder (SZ-12), Character with Grid, 2-D Grating, Paper Clip (SZ-50), Transmission Cross, Zero-Order Filter, Reading Micro-scope.

Theory

Abbe's theory assumes that the object to be imaged can be decomposed into a number of elemental gratings - each grating diffracts light at an angle that is a function of the grating period and the groove orientation. The diffracted beams are plane waves that can be focused by a lens to form diffraction patterns in the back focal plane of the lens, as seen in Figure 31-2. These diffraction patterns in turn act as sources of waves that propagate from the focal plane to the image plane where the image is produced. To say in a simple way, it can be considered as two steps: first step is to resolve the information, second is to synthesize the information.

If a spatial filter is applied on the spectral plane to allow some specific spatial frequencies to pass but block others, the final image will be altered according to the applied filter. Figure 31-3 shows some common filters.

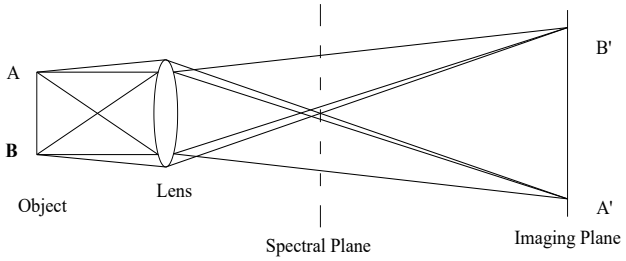
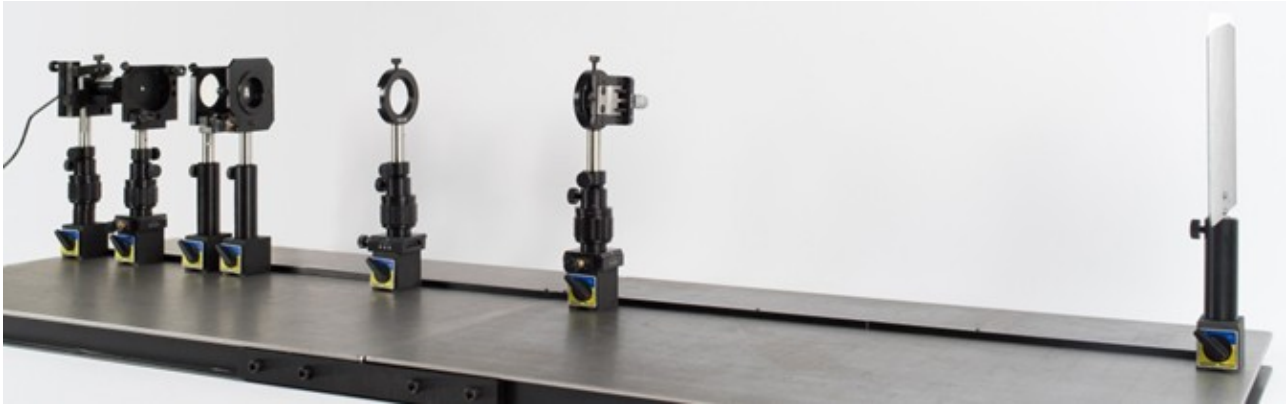


Figure 31-2 Schematic of Abbe's imaging

Figure 31-3 Types of spatial filters

Experiment Procedures

1. Refer to Figure 31-1, align all components in same height along a straight line;
2. Use L_1 and L_2 to construct a beam expanding system, to obtain a collimated beam with a larger aperture and illuminate on the transmission grating (1-D grating) whose grating grooves are in vertical direction;
3. Put a screen *P* away from the grating about 2 meters, move the transform lens L_3 back and forth to form a clear grating image on the screen;
4. Insert an adjustable slit (mounted on a Rotary lens holder SZ-06A and placed onto a magnetic base SZ-04) at the back focal plane of L_3, block all higher-order spectra except the zero-th order, check whether there are still grating lines in the image;
5. Adjust the slit width so that the zero-th order and the first order spectra pass through, observe the grating image, then remove slit, observe grating image again, compare the two cases;
6. Replace the transmission grating (1-D grating) with a 2-D grating, put an adjustable slit on the Fourier plane and set slit direction in vertical direction to pass the spectrum on Y axis, observe the direction of the grating lines on the image screen;
7. Rotate slit direction by 90° to let the X axis spectrum pass, observe the direction of the grating lines on the image screen;
8. Further rotate slit direction by 45°, observe the direction of grating lines direction on the image screen;
9. Replace the slit with the zero order filter (mounted on a plate holder SZ-12 and placed onto a magnetic base SZ-04), observe the image on screen;
10. Replace the zero order filter with the paper clip (insert a paper inside), use a needle to make holes at corresponding spectral spot locations, let desired spectral spots pass through the paper, observe the image of various spatial filters. Examples includes low pass, high-pass, directional pass, and so on;
11. Further, the Character with Grid or the 2-D Grating overlapped with the Transmission Cross can be used as the object to repeat the above experiments.



Lambda Scientific Systems, Inc.
16300 SW 137th Ave, Unit 132
Miami, FL 33177, USA
Phone: 305.252.3838 Fax: 305.517.3739
E-mail: sales@lambdasys.com
Web: www.lambdasys.com